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CALCIUM HYPOCHLORITE

Other Names	Calcium oxychloride, bleaching powder, chlorinated lime, $Ca(OCl)_2$
Description	Calcium hypochlorite is a white solid with a strong chlorine odour. The commercial product is sold as granules or pellets which contain up to 70% calcium hypochlorite. Bleaching powder or chlorinated lime is a mixture of calcium hypochlorite, calcium hydroxide and calcium chloride.

HAZARD SUMMARY

Exposure	Inhalation, skin and eye contact.
Effects of Short-Term Exposure	Calcium hypochlorite is a corrosive material. It can cause severe burns to skin and eyes. Particles or splashes in the eyes may result in permanent damage. Inhalation of dust or mist can cause irritation of nose and throat.
Effects of Long-Term Exposure	Information on long-term health effects is limited. Repeated skin contact causes drying, cracking and inflammation of the skin.
Fire and Explosion Hazards	Calcium hypochlorite is a strong oxidizing agent. It is not combustible but will cause combustible and flammable materials (such as oil or grease) to ignite on contact.
Fire Extinguishers	For fires involving calcium hypochlorite, use water sprays to extinguish fires and keep containers cool.
Chemical Reactivity	Calcium hypochlorite decomposes slowly at room temperature, releasing small amounts of chlorine gas. Heated calcium hypochlorite may decompose violently, giving off oxygen, chlorine and chlorine monoxide. Organic material such as wood dust and other flammable and combustible materials may ignite spontaneously and explosively when mixed with calcium hypochlorite.

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Chemical Reactivity	Chlorine gas is released when calcium hypochlorite is mixed with acids. Heat is generated on contact with small amounts of water which may lead to the decomposition of the solid.
Personal Protection	Wear protective clothing such as gloves, aprons and boots made of neoprene, polyvinyl chloride, butyl rubber or natural rubber. Wear splash-proof chemical safety goggles for eye protection. In dusty conditions, wear appropriate respiratory protection. The type of respirator needed depends on the concentration of airborne calcium hypochlorite. Use a NIOSH/MSHA approved air-purifying respirator equipped with acid gas cartridge and a dust/mist prefilter for handling and cleaning up small spills of this material.
Storage	Store calcium hypochlorite in well-sealed metal containers which are lined with rubber or other corrosion-resistant material. Use glass, plastic, cardboard or other calcium hypochlorite-resistant containers for storing small amounts.
Exposure Limits	The American Conference of Governmental Industrial Hygienists (ACGIH) has not recommended a Threshold Limit Value (TLV) for this substance. Appropriate government agencies in each jurisdiction should be consulted to determine which regulations apply. The TLV for chlorine gas is 1 ppm (3 mg/m3).

SCOPE OF THE DOCUMENT

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information may be available which bears on particular work situations. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments, and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981; toll free 1-800-263-8276.

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I. USES AND OCCURRENCE

Calcium hypochlorite is commercially available as solid mixtures containing about 30% to 70% $Ca(OCl)_2$. It can be purchased in powder, granular and pellet forms.

Calcium hypochlorite is used for disinfection of swimming pools and drinking water supplies. It is also used for treatment of industrial cooling water for slime and odour control, and in sewage and waste water treatment.

Calcium hypochlorite is used as a sanitizer in households, schools, hospitals and other public buildings. In addition, it is used for bacterial control, odour control and general sanitation in dairies, wineries, breweries, canneries, food processing plants and beverage bottling plants[1].

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II. TOXICOLOGY

Routes of Exposure
Inhalation is the main route of exposure for calcium hypochlorite dusts and mists. Solutions of calcium hypochlorite can contact the eyes and skin. Exposure to toxic amounts of chlorine gas will occur if calcium hypochlorite comes in contact with acids.

Further general information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body"[2].

Effects of Short-Term Exposures in Humans
The potential health hazards of this material are primarily due to its corrosive and reactive nature. The effects of exposure to calcium hypochlorite and its decomposition products depend mainly on the concentration and the duration of exposure.

Inhalation
There is little information available on the health effects of exposure to calcium hypochlorite. Exposure to dust and mist causes irritation of the nose and throat.

When it is mixed with acids, chlorine gas is released. Exposure to chlorine gas causes irritation of the nose and throat. Prolonged exposure to high concentrations of chlorine gas causes severe lung damage resulting in fluid accumulation in the lungs.

Effects on the Eyes
Exposure to calcium hypochlorite dust and mist causes eye irritation.

Concentrated solutions of calcium hypochlorite cause severe burns which may result in permanent eye damage.

Effects on the Skin
Calcium hypochlorite dust and solution cause irritation. In severe cases, when the chemical is not rinsed off quickly with water, chemical burns may occur.

Skin contact with pastes containing 0.54 to 32.55% calcium hypochlorite causes redness of the skin, inflammation (dermatitis) and bleeding[3].

Ingestion
Ingestion of calcium hypochlorite is unlikely to occur in the workplace. Swallowing the solid chemical or a concentrated solution causes burns to the mouth and the digestive tract. There is pain in the

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stomach, vomiting, difficulty in breathing, confusion, delirium and, in severe cases, coma and death[4].

Effects of Long-Term Exposures
There are no reports of chronic poisoning from exposure to calcium hypochlorite. Repeated skin contact causes drying, cracking and inflammation of the skin[5].

Mutagenic Effects
In one study, calcium hypochlorite was weakly mutagenic following short-term tests on bacteria[6]. The significance of these tests for human exposure is uncertain.

Toxicity Data in Animals
The relative poisoning potential of a compound can be assessed from the LD_{50} obtained in animal tests. The LD_{50} is the amount of a chemical (weight of chemical/weight of animal) which is needed to kill one-half (50%) of the test animals. Test animals are usually rats, mice, or other rodents. Routes of exposure are usually oral (by mouth) or dermal (absorption through the skin). The values for this material are:

LD_{50} (rat, oral)	850 mg/kg[7]

Further general information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[8].

In one experiment, 5% calcium hypochlorite in water (pH of 11.5) was applied to rabbit eyes for thirty seconds, followed by irrigation with water. The solution caused slight, reversible damage to the eyes[9].

III. FIRE HAZARDS

Calcium hypochlorite is not combustible but it is a strong oxidizing agent. There is a risk of fire and explosion when it comes in contact with flammable and combustible materials such as oil or grease. When calcium hypochlorite is heated to temperatures above 150°C, oxygen is released which can increase the intensity of fires[10]. Chlorine and chlorine monoxide gases may also be produced under certain conditions. Chlorine monoxide can react explosively with flammable and combustible materials.

Fire Extinguishing Agents
Water spray is the most effective extinguishing agent for fires involving calcium hypochlorite. Water spray also cools and prevents

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rupture of containers involved in a fire. In addition, water spray reduces the amounts of toxic gases which are given off.

Chemical Reactivity
Calcium hypochlorite is a reactive and unstable chemical. Solid calcium hypochlorite and its solutions react violently with acids, releasing poisonous chlorine gas[11].

Explosions occur when metals such as copper, nickel and cobalt come in contact with calcium hypochlorite[3]. Contact with impurities such as iron oxide (rust) and other metal oxides produces oxygen and causes the container to rupture explosively[12].

Calcium hypochlorite has an unusual and especially hazardous property. Once heat or impurities start to cause decomposition, sufficient heat is generated to allow total decomposition to occur[13]. Reactions generating excess heat occur when calcium hypochlorite is mixed with non-ionic detergents and cationic algicides[10].

Never allow calcium hypochlorite to come in contact with flammable and combustible materials. Ammonia, urea and primary amines react with calcium hypochlorite to form chloramines which are irritating, nauseating and, in some cases, explosive.

IV. EXPOSURE CONTROL

Use general (dilution) ventilation for operations where only small amounts of calcium hypochlorite become airborne. In dusty conditions or if a mist is generated, local exhaust ventilation and other engineering controls may be necessary. Exhaust contaminated air directly to the outside. Use corrosion-resistant equipment. Further information on the design of local exhaust ventilation systems is available in the ACGIH ventilation manual[14].

Although engineering controls such as ventilation are the preferred methods of controlling exposure to contaminants in the workplace, personal protective equipment such as special clothing and respirators may increase the level of protection for workers exposed to this material. In some situations, such as working in enclosed spaces and in some maintenance operations, personal protective equipment may be essential since effective ventilation and engineering controls may not be possible.

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Eye Protection
Wear splash-proof chemical safety goggles for eye protection. A face shield may also be worn but is not generally required when handling solid materials (e.g. granules, pellets or tablets). Provide eyewash fountains and safety shower facilities for emergencies.

Skin Protection
Wear protective clothing such as gloves, coveralls, aprons and overshoes when handling calcium hypochlorite. Use chemical protective clothing made of neoprene, polyvinyl chloride, butyl rubber or natural rubber[15].

Respiratory Protection
Factors to be considered when implementing a respiratory protection program include:

Selection of appropriate respirators
Respirator fit
Respirator maintenance
Worker training

These factors are described in more detail in CSA Standard Z94.4-M1982, "Selection, Care, and Use of Respirators", available from the Canadian Standards Association.

In dusty conditions, use a National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA)-approved respirator with an acid-gas cartridge and a dust prefilter[16]. An acid-gas cartridge is necessary to trap any release of chlorine gas. If there is irritation of the eyes, use eye protection. Observe the respirator use limitations specified by NIOSH/MSHA or the manufacturer.

Note: Air-purifying respirators do not protect against oxygen-deficient atmospheres.

V. SMALL-SCALE STORAGE AND HANDLING

Store calcium hypochlorite in air-tight metal containers which are lined with rubber or other corrosion-resistant material. Use cardboard, plastic or other calcium hypochlorite-resistant container for storing small amounts.

Store in a cool, dry, clean and well-ventilated area with a non-combustible, corrosion-resistant floor and approved drainage[12].

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Protect containers from damage or breakage, and store away from incompatible materials. Avoid storage for prolonged periods of time[17]. Regularly and carefully inspect containers for damage and corrosion. Use only corrosion-resistant equipment in the storage area.

Use calcium hypochlorite in minimal quantities in designated areas and away from incompatible materials. Ensure scoops, containers and other equipment used for handling calcium hypochlorite are free of contamination. Dissolve solid calcium hypochlorite in plain water only. Add the solid slowly to the water with constant stirring. Never add water to the solid calcium hypochlorite because sufficient heat may be generated to initiate hazardous decomposition.

Clean-Up

Wear protective clothing for clean-up operations. A NIOSH/MSHA-approved air-purifying respirator equipped with acid gas cartridges and a dust/mist prefilter may be adequate for most spills. If chlorine gas concentrations exceed 10 ppm, wear a positive-pressure atmosphere-supplying respirator with full facepiece. Restrict untrained personnel from the spill or leak area until clean-up is complete. Ventilate the area well. Remove all ignition sources and incompatible materials from the area. Prohibit smoking. Notify the appropriate governmental authorities if calcium hypochlorite is released into the environment.

Stop the source of the leak if it can be done safely. For small spills, collect the material using a *clean*, dry shovel and broom and transfer to a container of water. If possible, reclaim the resulting solution but ensure that the reclaimed hypochlorite is not contaminated. If reclamation is not possible, carefully "neutralize" the solution by adding one pint (approximately 0.5L) of 35% hydrogen peroxide for each pound of calcium hypochlorite[16]. Neutralization with hydrogen peroxide produces oxygen which will bubble out of the solution. Carry out the neutralization in open containers in well-ventilated areas. Once the bubbling has ceased, the neutralization is complete.

Other chemicals which can be used to neutralize calcium hypochlorite are sodium sulfite and sodium bisulfite. Once the calcium hypochlorite has reacted completely with either sodium sulfite or sodium bisulfite, a corrosive solution is formed. The corrosive solution can be rendered less harmful by adding controlled amounts of dilute hydrochloric or sulfuric acid[18].

For large spills, contact police and emergency services and the supplier for assistance.

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Disposal
Federal, provincial, territorial and local regulations should be reviewed prior to disposal of waste calcium hypochlorite.

Never discharge untreated waste calcium hypochlorite directly into sewers or surface water. Following treatment either at the spill site or a waste management facility, dispose of waste material in a secure landfill.

VI. FIRST AID

The following general procedures are suggested for first aid involving poisoning by calcium hypochlorite:

Inhalation
Remove the source of calcium hypochlorite or move the victim to an uncontaminated area. Give artificial respiration if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if the heart has stopped. Obtain medical attention immediately. Administration of oxygen by a person trained in its use may be beneficial and may prevent fluid accumulation in the lungs. Fluid accumulation within lungs is not caused by overexposure to calcium hypochlorite dust or mist. It is the chlorine produced by decomposition of calcium hypochlorite which poses the risk of lung damage.

Eyes
If irritation occurs due to exposure to dust or mist, or if solutions of calcium hypochlorite are splashed into the eye(s), flush the affected eye(s) for *at least* 30 minutes by the clock. Use lukewarm, gently flowing water, while holding apart the upper and lower eyelid(s). Take care not to rinse contaminated water into the non-affected eye. Obtain medical attention immediately.

Skin
If solutions of calcium hypochlorite are splashed on the skin or if the dust or mist irritates the skin, flush the affected area with lukewarm, gently running water for *at least* 15 minutes by the clock. Protect the eyes and uncontaminated skin from contamination. Remove contaminated clothing, shoes and leather goods (such as watchbands) under running water. Thoroughly wash these items and decontaminate before reuse. Obtain medical advice immediately.

Ingestion
Never give anything by mouth if the victim is rapidly losing consciousness, or is unconscious or convulsing. In all cases, rinse

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any residual calcium hypochlorite from the mouth with water. Because of the corrosive nature of this material, do not induce vomiting. Instead, give 240 to 300 mL (8 to 10 ounces) of water to the victim to dilute the material in the stomach. If vomiting occurs naturally, make the victim lean forward to reduce the risk of calcium hypochlorite entering the lungs. Afterwards, give the victim an additional 8 to 10 ounces of water to drink. Obtain medical attention immediately.

Note: Provide general supportive measures (comfort, warmth, rest). Consult a physician and/or the nearest Poison Control Centre for all cases of ingestion or eye contact and all but trivial cases of inhalation or skin contact. All first aid procedures should be periodically reviewed by a physician familiar with the material and its conditions of use in the workplace.

VII. EXPOSURE LIMITS

In many Canadian jurisdictions, exposure limits are similar to the ACGIH TLVs. A TLV has not been established for this substance. Appropriate government agencies in each jurisdiction should be consulted to determine which regulations apply.

Warning Properties of Calcium Hypochlorite
There are no reported odour threshold values for this material. It should be noted, however, that calcium hypochlorite decomposes slowly at room temperature, releasing chlorine gas. The range of odour threshold values reported for chlorine is 0.03 - 15 mg/m^3 (0.01 - 5 ppm)[19].

Exposure Limits in Other Nations
The approaches or mechanisms for establishing and applying occupational exposure limits can vary widely from country to country. Information on exposure limits in a number of foreign jurisdictions is available from CCOHS.

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VIII. CHEMICAL AND PHYSICAL PROPERTIES

Chemical formula	$Ca(OCl)_2$
CAS Registry Number	7778-54-3

Physical Properties[3]

Percent chlorine by weight	49.6
Melting point	decomposes above 100°C
Density	2.35 g/cm^3
Solubility in water	21.5 g/100 mL at 0°C 23.4 g/100 mL at 40°C
Flash point	not combustible
pH	11.5 (5% solution)

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Note: Additional references on this subject are available from CCOHS upon request.

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